Microanatomy of the Nephron
Blood Flow in Kidney

(a) Cortical radiate veins
(b) Glomerulus
(c) Afferent arterioles

Renal vein
Renal artery
Segmental arteries
Interlobar veins
Interlobar arteries
Arcuate veins
Arcuate arteries
Cortical radiate veins
Cortical radiate arteries
Venules
Afferent arterioles
Efferent arteriole

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Overview of a Nephron

**NEPHRON**

Proximal convoluted tubule:
- Reabsorption of water, ions, and all organic nutrients

Distal convoluted tubule:
- Secretion of ions, acids, drugs, toxins
- Variable reabsorption of water, sodium ions, and calcium ions (under hormonal control)

Capsular space
- Glomerulus
- Efferent arteriole
- Afferent arteriole
- Glomerular capsule

Renal corpuscle:
- Production of filtrate

KEY
- Water
- Solute
- Filtrate
- Variable reabsorption or secretion

**COLLECTING SYSTEM**

Collecting duct:
- Variable reabsorption of water and reabsorption or secretion of sodium, potassium, hydrogen, and bicarbonate ions

Papillary duct:
- Delivery of urine to minor calyx

Minor calyx
Structures of/near Nephron

• Renal corpuscle:
  – Location: Cortex
  – Components:
    • Glomerulus
    • Bowman’s capsule

• Renal tubule:
  – Locations: Cortex (Medulla – Loop of Henle)
  – Components:
    • Proximal Convoluted Tubule (PCT)
    • Loop of Henle (Nephron Loop)
    • Distal Convoluted Tubule (DCT)
Renal Corpuscle

- Efferent arteriole
- Distal convoluted tubule
- Macula densa
- Juxtaglomerular cells
- Juxtaglomerular complex
- Afferent arteriole
- Capsular space
- Glomerular capillary
- Capsular epithelium
- Visceral epithelium (podocyte)
- Glomerular capsule
- Proximal convoluted tubule
Renal Corpuscle

<table>
<thead>
<tr>
<th>Glomerulus</th>
<th>Bowman’s Capsule</th>
</tr>
</thead>
<tbody>
<tr>
<td>• A capillary network/knot inside Bowman’s capsule</td>
<td>• Located at closed end of nephron</td>
</tr>
<tr>
<td>• Blood exits glomerulus via efferent arteriole &amp; flows into secondary capillary network</td>
<td>• A cup-like double walled chamber</td>
</tr>
<tr>
<td>• Secondary capillary network surround renal tubule</td>
<td>• Contains glomerulus &amp; connected to initial segment of renal tubule</td>
</tr>
</tbody>
</table>
Renal Corpuscle – Epithelial Tissue

Glomerulus

• Lining of capillaries (visceral epithelium) → simple squamous

• Podocytes wrap around dense layer of glomerulus capillaries

Bowman’s Capsule

• Lining of outer capsule wall (parietal epithelium) → simple squamous
# Microscopic Anatomy of the Nephron

<table>
<thead>
<tr>
<th>Region</th>
<th>Length</th>
<th>Diameter</th>
<th>Primary Function</th>
<th>Histological Characteristics</th>
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<tbody>
<tr>
<td><strong>NEPHRON</strong></td>
<td></td>
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</tr>
<tr>
<td>Renal corpuscle</td>
<td>150–250 μm</td>
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<td>Filtration of plasma</td>
<td>Glomerulus (capillary knot), mesangial cells, and dense layer, enclosed by the glomerular capsule; visceral epithelium (podocytes) and capsular epithelium separated by capsular space</td>
</tr>
<tr>
<td>Capsular space</td>
<td>(spherical)</td>
<td></td>
<td></td>
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<tr>
<td>Capsular epithelium</td>
<td></td>
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<tr>
<td>Capillaries of glomerulus</td>
<td></td>
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<td>Visceral epithelium</td>
<td></td>
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<td>Renal tubule</td>
<td>14 mm</td>
<td>60 μm</td>
<td>Reabsorption of ions, organic molecules, vitamins, water; secretion of drugs, toxins, acids</td>
<td>Cuboidal cells with microvilli</td>
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<td>Proximal convoluted tubule (PCT)</td>
<td></td>
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Renal Tubule

• **Proximal Convoluted Tubule**
  – Twisted/coiled tube closest to the renal corpuscle
  – 1st segment of renal tubule

• **Loop of Henle**
  – U shaped tube that extends into medulla (partially)
  – Subdivided into descending limb & ascending limb

• **Distal Convoluted Tubule**
  – Twisted/coiled tube farthest from the renal corpuscle
  – 3rd segment of renal tubule
  – Smaller in diameter than PCT
Proximal Convoluted Tubule
Renal Tubule – Epithelial Tissue

• **Proximal Convoluted Tubule**
  – Lined with **simple cuboidal** epithelium with microvilli on the apical surfaces of cells (Brush border)

• **Loop of Henle**
  – Each limb = thick & thin segment (height of epithelium)
    • Thick segments: cuboidal epithelium
    • Thin segments: squamous epithelium

• **Distal Convoluted Tubule**
  – Lined with **simple cuboidal** epithelium (Lack microvilli)
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<tr>
<td>Microvilli</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td><strong>Nephron loop</strong></td>
<td>30 mm</td>
<td>15 μm</td>
<td>Descending limb: reabsorption of water from tubular fluid</td>
<td>Squamous or low cuboidal cells</td>
</tr>
<tr>
<td></td>
<td></td>
<td>30 μm</td>
<td>Ascending limb: reabsorption of ions; assists in creation of a concentration gradient in the medulla</td>
<td></td>
</tr>
<tr>
<td><strong>Distal convoluted tubule (DCT)</strong></td>
<td>5 mm</td>
<td>30–50 μm</td>
<td>Reabsorption of sodium ions and calcium ions; secretion of acids, ammonia, drugs, toxins</td>
<td>Cuboidal cells with few if any microvilli</td>
</tr>
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Collecting System

Collecting duct
Variable reabsorption of water and reabsorption or secretion of sodium, potassium, hydrogen, and bicarbonate ions

Papillary duct
Delivery of urine to minor calyx

KEY
- Water
- Solutes
- Filtrate
- Variable reabsorption or secretion

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Collecting System

• Collecting Duct
  – Originates in cortex & descends into medulla
  – Simple cuboidal epithelium

• Papillary Duct
  – Composed of several converged collecting ducts
  – Located in medulla & drains into minor calyx
  – Simple columnar epithelium
### Collecting System – Epithelial Tissue

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<td>Collecting duct</td>
<td>15 mm</td>
<td>50–100 μm</td>
<td>Reabsorption of water, sodium ions; secretion or reabsorption of bicarbonate ions or hydrogen ions</td>
<td>Cuboidal to columnar cells</td>
</tr>
<tr>
<td>Papillary duct</td>
<td>5 mm</td>
<td>100–200 μm</td>
<td>Conduction of tubular fluid to minor calyx; contributes to concentration gradient of the medulla</td>
<td>Columnar cells</td>
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Types of Nephrons

- **Cortical nephrons**
  - Main type of nephron in kidney (85%)
  - Shorter Loop of Henle

- **Juxtamedullary nephrons**
  - Minor type of nephron (15%)
  - Longer Loop of Henle extends deep in medulla
    - Plays vital role in water conservation & formation of concentrated urine